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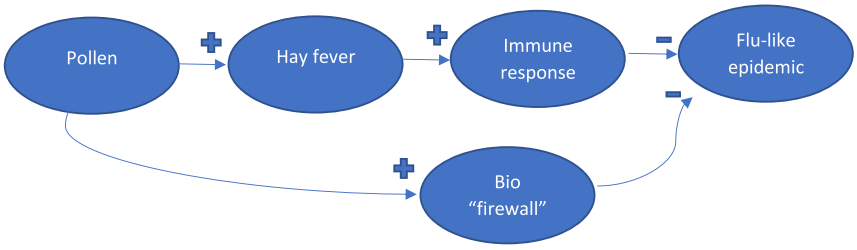
Short Communication

Pollen likely seasonal factor in inhibiting flu-like epidemics. A Dutch study into the inverse relation between pollen counts, hay fever and flu-like incidence 2016–2019

Martijn J. Hoogeveen

Open University Netherlands, De Liesbosch 12d, 3439LC Nieuwegein, the Netherlands

GRAPHICAL ABSTRACT



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ABSTRACT

There is uncertainty if current models for the Covid-19 pandemic should already take into account seasonality. That is because current environmental factors do not provide a powerful explanation of such seasonality, especially given climate differences between countries with moderate climates. It is hypothesized that one major factor is overlooked: pollen count. Pollen are documented to invoke strong immune responses and might create an environmental factor that makes it more difficult for flu-like viruses to survive outside a host. This Dutch study confirms that there is a (highly) significant inverse correlation between pollen count and weekly changes in medical flu consults, and that there is a highly significant inverse correlation between hay fever incidence, as measured by prescribed medication revenues, and weekly flu consults. This supports the idea that pollen are a direct or indirect factor in the seasonality of flu-like epidemics. If seasonality will be observed during the covid-19 spread as well, it is not unlikely that pollen play a role.

1. Introduction

Virologists observe already for many years that the cold, and flu-like epidemics (influenza and corona caused) "go away in May" in the Northern Hemisphere, to move to the Southern Hemisphere, and return next Autumn and Winter in a slightly mutated form. Further, it is observed that these strains of viruses have a lower reproduction factor in tropical countries, outside the rain season. It is observed that possible inhibiting environmental factors in these epidemics are UV light (Schuit et al., 2020), temperature and humidity (Chong et al., 2020) and behavioral changes during the seasons (Gozzi et al., 2020). None of these environmental factors seems to

E-mail address: martijn.hoogeveen@icecat.com.

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be completely satisfactory to explain the seasonality of flu-like epidemics, which is very important to understand in the light of ongoing modelling efforts for the current Covid-19 pandemic.

The relation between the seasons and the flu-like epidemics can be an indirect relation, whereby there is actually an overlooked intermediate factor at play: the natural pollen "firewall" that typically peaks in April, is still active during the remainder of Spring and Summer, to start to lose its footing in August. Pollen are observed to be at play in plant biology: plant viruses can be transported through pollen (Bhat and Rao, 2020). Further, pollen play a well-researched role in triggering human immune responses.

To hypothesize in what ways pollen could be an environmental factor influencing the life cycle of flu-like epidemics, the objective of this quick study is to falsify the hypothesis that there are no *significant* inverse correlations between pollen counts, pollen induced immune responses, and flu-like epidemic life cycles in The Netherlands. An interdisciplinary, environmental view might lead to new insights (Reijnders and Hoogeveen, 2001).

2. Method

To establish whether the hypothesized inverse correlations between allergenic pollen counts per m3, pollen induced immune responses, and previous flu-like incidence are significant, we used the public data sets of the Dutch Central Bureau of Statistics (CBS) about the weekly pollen count in The Netherlands and revenues of (anti-histamine) medication against the effects of hay fever (2016 = 100), and the data from RIVM (the Dutch State Institute for Public Health) about weekly flu-like incident reports at the primary medical care per 100,000 Dutch citizens. The overlapping data period of both data sets is taken, which runs from week 1 of 2016 till week 10 of 2019 ($n = 166$). Regarding the incidence of flu-like symptoms, we also calculated the weekly change compared to the previous period to get an indication of the flu-like epidemic life cycle progression.

We formulated three statistical null hypotheses

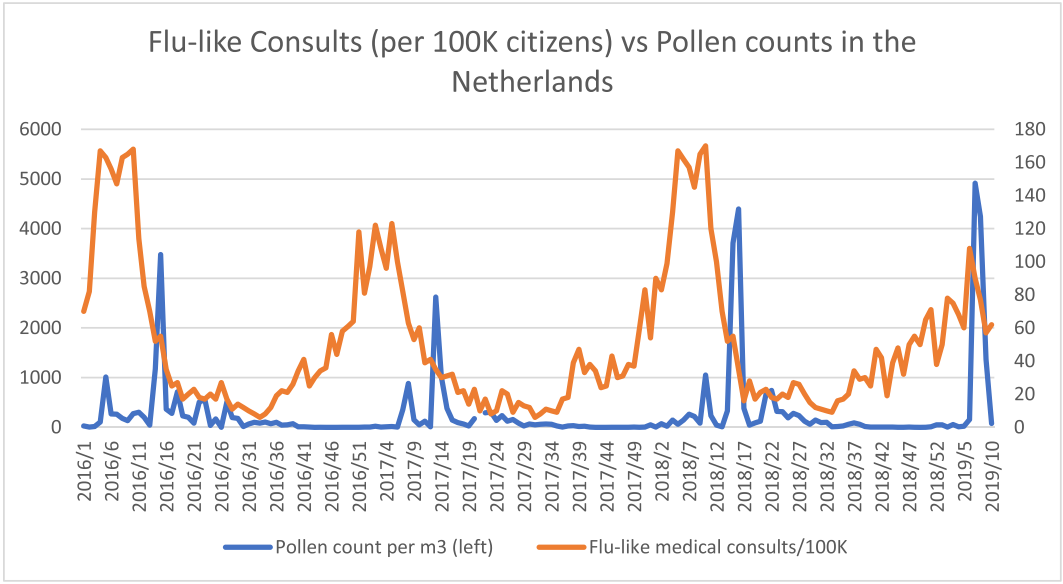
H1(0). There is no inverse correlation between pollen count and flu-like reports.

H2(0). There is no inverse correlation between pollen count and weekly changes in flu incidents.

H3(0). There is no inverse correlation between hay fever symptoms and flu-like reports.

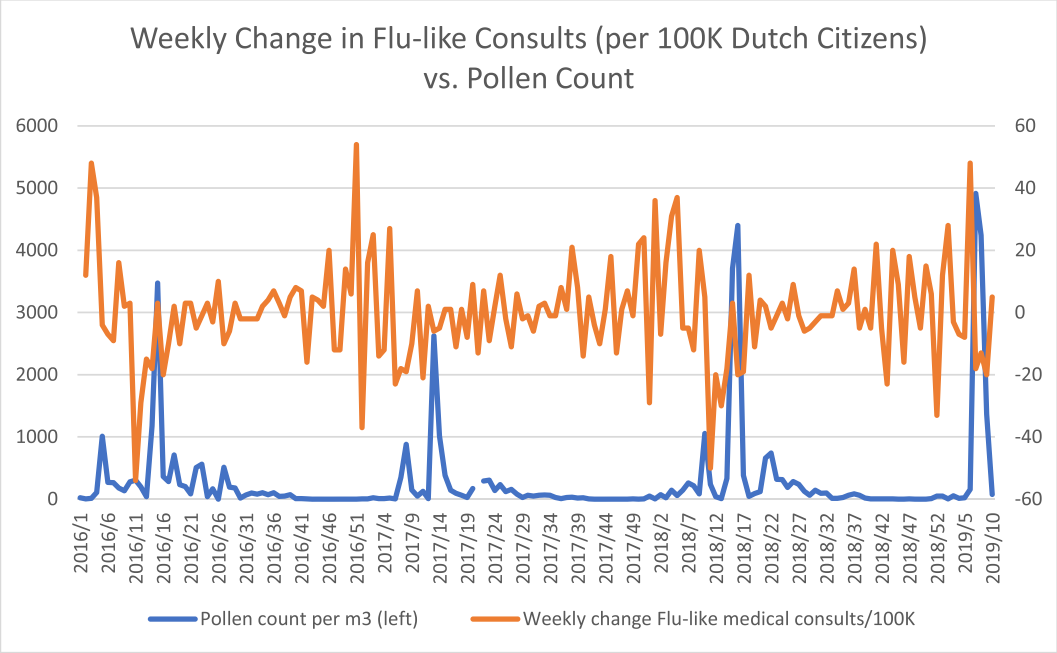
It is outside of the scope of this quick research to verify the underlying data sets of CBS and RIVM by examining the raw data, and validity and reliability of data collection methods.

3. Results



When inspecting the data sets regarding pollen counts and flu-like consults at primary medical care in The Netherlands, it is clear that there are a few pollen bursts, especially during Spring, and then at a lower level during Summer. These bursts typically coincide with a decline of flu-like consults.

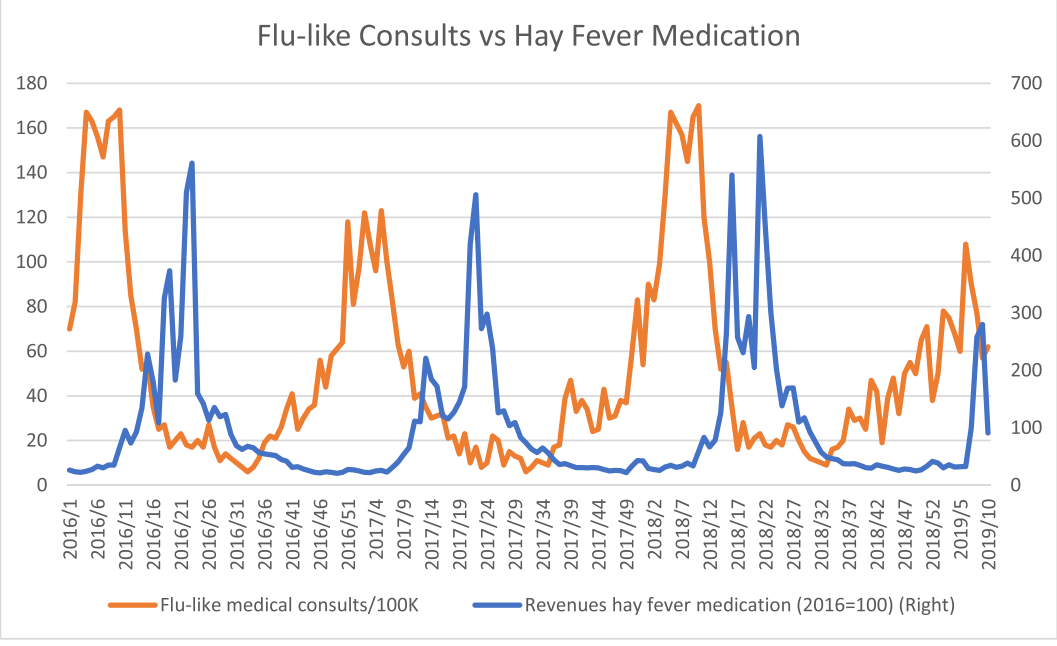
Given the burst like phenomenon, it is not strange that we found no clear correlation between pollen count and the incidence of flu-like medical consults for our data set (correlation coefficient: .07). Therefore, we cannot falsify the hypothesis that there is no relation between pollen count and the overall count of flu-like symptoms.



However, we found a clear inverse correlation coefficient of −.18 between pollen count and weekly change of medical flu consults. The *P*-Value is .02, thus the result is significant at $p < .05$. Therefore, we can falsify the hypothesis that there is no inverse correlation between the weekly pollen count and changes in flu-like consults. This inverse correlation might provide further support for the idea that the presence of (a lot of) pollen has an inhibiting effect on flu incidence, and starts to immediately influence the direction and course of the epidemic life cycle.

If we correct the correlation for incubation period by comparing pollen count with the next week's change in medical consults the correlation coefficient becomes stronger and highly significant at −.24 ($p < .01$). *P*-Value is .001661 at $n = 165$. We can still reject the null-hypothesis that there is no inverse relation between pollen count and flu-like consults (corrected for incubation period). As this correlation is stronger than if not corrected for incubation period, it is a further indication of sequentiality as a causality criterion.

The pollen impact threshold value (PITV), based on the observations is around 70 pollen/m^3, i.e., the annual upward and downward turning points in flu-like medical consults are all marked by the weekly pollen levels passing an average threshold of 70 pollen/m^3 (±30 pollen/m^3). In the Netherlands. In each of the observed years the threshold is past around week 10, which coincides also with the flu-like peak, and again in week 33 (±1 week) marking the start of the flu-like season.



The visually most clear inverse relation is between hay fever medication and flu-like medical consults. The inverse correlation coefficient is −.34. The *P*-Value is .00001, and thus the result is highly significant at $p < .01$. Therefore, we can also falsify the hypothesis that there is no

inverse correlation between hay fever symptoms (or at least hay fever medication revenues) and flu-like consults. This inverse correlation might provide support for the idea that the triggering of immune responses by pollen (i.e., hay fever) – coughing, sneezing, histamine responses, etc. - makes it more difficult for flu-like viruses to penetrate a new host.

4. Conclusion

The (highly) significant results show that there is an inverse relation between pollen counts and the life cycle of flu-like epidemics, and a somewhat stronger inverse relation between pollen induced immune responses (as measured by revenues for anti-hay fever medication) and flu-like medical consults. This gives support to the idea that an activated immune system makes it more difficult for flu-like viruses to penetrate a new host. At the same time, there might also be an environmental factor at play: more pollen in the air might make it more difficult for a flu-like virus to survive outside a host. Like a pollen firewall. We can also observe that the sequentiality criterion for causality is met.

It will require further research to understand whether the same inverse correlations are found in other countries with moderate climates, and whether pollen play a similar role in tropical countries as well. It is good to compare a variety of climatological diverse countries to check for meteorological variations regarding UV light, humidity and temperature. It is very interesting to understand whether also in other countries and years a PITV of around 70 pollen/m^3 ($\pm$30) is found for moderate flu-like epidemics, and if this threshold value can be further understood in the light of the more aggressive Covid-19 pandemic. Further, it is good to understand better the interaction between aerosol pollen and flu-like viruses, and whether general immune responses are indeed a causal factor in reducing the spread of flu-like viruses. Finally, it still needs to be observed whether the covid-19 (SARS-CoV-2 virus) spread will be seasonal – "going away in May" – whereby the pollen factor could be studied as a directly or indirectly inhibiting factor, potentially.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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